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ABSTRACT

Instruction and learning encompass more processes than are included in learning theories themselves. Instruction involves gaining and controlling attention, stimulating recall, guiding the learning, providing feedback, arranging for remembering, and assessing outcomes. These functions are performed by various media of instruction, but ultimately by the learner himself. Learning is, after all, an individual matter. It is unlikely that one single medium is best fitted to perform all the functions of learning. It seems likely that carefully designed combinations of media may be required to achieve the kind of instruction that is now effective, and which at the same time exploits the properties of media to the best advantage. (Author/GO)

Learning Theory, Educational Media, and Individualized Instruction

Robert M. Gagné *

Instruction of college and university students is an activity not customarily derived in a deliberate fashion from theories about learning. Most college instructors set about their initial task of teaching courses by using a model derived from their own college experiences; in other words, they try to emulate their own professors. The new instructor may spend many hours in selecting a text and other references, in planning what he will say to his class of students, in seeing how certain topics will "fit" a semester of so many weeks. But the question of just what the students are going to be doing during these weeks, and how their activities are going to affect their capabilities, is not likely to be given a great deal of thought.

In proceeding in this manner to face the task of college instruction, it is obvious that the new instructor is perpetuating many traditions. He is planning his work in terms of the content of knowledge to which students will be exposed, the kinds of communication he will make to them in lectures. He is selecting for students a minimal set of readings and oral communications to which they will be "exposed." He is thinking in terms of how much reading material and orally-presented material his students may be expected to "absorb" during a given period of weeks. All of these activities are traditional in the sense that they are the same ones he himself was subjected to; they resulted in the framework for instruction as he experienced it.

It is also true that this traditional system may be said to "work." The young instructor knows that, because it has worked for him and for most of his fellow students. Why does it work? Under what circumstances does it work? One suspects that it works within the confines of two major conditions: (1) first, that students attending college are highly selected to accomplish learning in just this fashion; and (2) second, that what they are expected to accomplish represents a limited set of educational goals.

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To treat these questions fully, and to deal with all of their implications would require a different direction than the one this paper is supposed to take. I shall therefore have to be content to suggest the lines of questioning that seem to me to be opened up by identifying these limiting conditions of traditional college instruction. Do we want to select just those students for college who are most able to learn by traditional means? By our selection procedures, are we simply perpetuating patterns of thought and learning that are first laid down in high school and earlier? Are we in danger of screening out by such procedures many individuals whose potential contributions to our culture are the most unusual? Are traditional methods of instruction best adapted to prepare the student for the activities of graduate school, where greater independence of thought is expected? Are these methods, in fact, preparing the student to be both an independent thinker and a continuing learner?

If one admits these kinds of questions into his thinking about the nature of college instruction, one faces the problem of understanding the nature of instruction itself, and in particular, what instruction has to do with human learning. One is led to examine the ways in which things, events, and ideas about them are presented to the human learner; in fact, the ways in which relevant stimulation impinges upon the learner from his environment. Further, one is led to a consideration of what happens to this stimulation when it reaches the nervous system of the learner - - in other words, what kinds of transformations it undergoes. For we know that this environmental stimulation is processed in at least several different ways: this is the kind of inference we make when we say that the human individual has changed in the sense that he has learned something.

Media. The first of these problems of stimulating the human learner, represents the area of media of communication. Generally, we tend to describe media in terms of the material things that provide the vehicles for the "messages" - - as, textbooks, newspapers, blackboards, motion picture projectors, television systems. However, for the purposes of considering their effects on learning, there are advantages to attending instead to the kinds of channels they offer. Considered in this way, one may conveniently describe media in several major categories as follows:

(1) actual objects and events
(2) veridical pictures (static and moving)
(3) diagrammatic pictures
(4) printed language
(5) auditory language.

These are the different ways in which the learner is affected by media. He may be stimulated by actual objects and events, and a reasonable portion of his learning results from such stimulation. Once he has learned how, in his early years, the learner may be stimulated with apparently equal effect by pictures, whether he sees them in a textbook, on a movie or television screen. Again, following some early learning, he responds to diagrammatic pictures, which are of several varieties. He responds to a two-dimensional representation of a cube as if it were a cube, for example; and in a more abstract way, he comes to understand the communication of a bar chart or line graph. As schooling proceeds, learning comes to depend increasingly on the stimulation provided by printed language. There is surely much truth in the definition of a university as a collection of books; even though one recognizes this to be an ironically partial truth nowadays. Auditory language has always been another major source of information for use in learning, whether presented by itself as in a lecture, or combined with the pictorial mode as in a motion picture or television program.

Learning theory. These are the ways, then, that stimulation is presented to the human learner. The second part of the problem to be considered concerns what happens to this stimulation when it reaches the learner. How is it transformed in such as way as to change his capabilities from one state to another? What kind of processing does it undergo in leading his professors to conclude that he has learned?

Obviously, this is the area of learning theory. Psychologists have studied, experimented upon, speculated about, and generally tried to understand learning for many years. Progress has not been rapid, but it surely appears to have been speeded by the application of experimental methods in use for about the last sixty years. As is not unusual with phenomena of living things, learning is a complicated process, occurring in many varieties, forms, and situations. It is necessary first, therefore, to recognize that learning theory as it exists today is a highly inelegant and unfinished entity. Nevertheless, there do appear to be some fairly fundamental and stable principles which serve to tell us what learning is not like, and to suggest the outlines of what it is like.

Sorting out the general principles from the more specific ones in learning theory is by no means an easy task. Similarly, selecting those principles of learning which are most highly relevant to the practical

problem of instruction is not a self-evident procedure. The reason for this is that modern learning investigators have chosen different models to study, and they are intent on accounting for these models. Sometimes, these models resemble the learning of the school child, or the college student, and sometimes they do not. For example, the prototype learning situations represented in a recent influential book on Categories of Human Learning, (Melton, 1964), are approximately as follows:

(1) Conditioning: Learning to blink the eye to a signal
(2) Rote learning: Learning to memorize pairs and lists of words
(3) Probability learning: Learning to choose a correct alternative from a set of words or objects
(4) Short-term memory: Initial reception and storage of information, usually a syllable or word
(5) Concepts: Learning of simple object properties by young children
(6) Perceptual-motor skill: Learning to make continuous tracking movements
(7) Problem solving: Discovering a principle which achieves a stated goal.

Obviously, not many of these prototype learning situations, in and of themselves, sound much like "learning the facts of history from a textbook," or like "learning to demonstrate Coulomb's Law in the laboratory." Nevertheless, at some level of generality, these models all contribute to learning theory. For example, short-term memory, the initial reception of information, is an important part of every learning act. In considering how such principles apply to practical learning situations, it is mainly a matter of deciding what can be assumed to be going on without a hitch, as contrasted with what requires critical planning and arrangement.

The design of effective instruction, then, has these two areas of knowledge to call upon. Instruction needs to be arranged so that it will bring about the kind of change in a student which is called learning, and this requires a consideration of learning theory. In attempting to bring about such a change, the act of instruction is a matter of stimulating the student in certain ways - - and here one has a choice of media to work with. Putting ideas together from these two domains of knowledge can yield some techniques and procedures of instruction which should make the process of learning an optimally effective one.

ggestions from Learning Theory

What specific suggestions about instruction can be derived from learning theory? As I have already noted, these are not self-evident. There are many learning theories, and most of them are micro-theories, designed to provide models of some relatively specific kinds of learning. Accordingly, a selection must be made among them, keeping in mind the purpose of orientation toward the learning of young adults, or college students, and with an awareness of the variety of media available.

I believe there are four different learning theorists who have presented ideas of major importance to the design of instruction. These are Neal Miller, Skinner, Gagne, and Ausubel. I intend to describe these ideas briefly here, before going on to elaborate on their implications. It will be apparent that the suggestions of these theorists vary in their specificity, and I have ordered them along this dimension. Miller's ideas are the most general, applying to a great variety of learning situations. The specificity of suggestions increases progressively through the theory f Ausubel, who attempts to deal in a highly concentrated manner with the problem of acquiring meaningful, organized knowledge.

N. E. Miller. Miller's views regarding the implications of learning theory for instruction are presented in a volume of the Audio-Visual Communication Review, entitled Graphic Communication and the Crisis in Education (1957). The four principles he describes are suggested by the words: motivation, cue, response, reward. It is Miller's contention that an effective sequence of instruction, in any medium, must include provision for these four conditions.

First, motivation: the student must want something. The motivational effects of a "lesson" depend upon motivation which has already been learned. To be most effective, the motivations aroused by instructional materials must build upon those that are already in the life experiences of the student. In other words, instructional materials cannot in themselves be expected to generate brand-new sources of motivation; but what they can and should do is to capitalize upon, and add to, the kinds of motivations that are already there. Various kinds of motivation may be called upon, including some presumably fundamental ones such as intellectual curiosity and the desire to achieve. For students in college, learned motivations which form a part of the individual's life goals, and which may exhibit themselves as identification with admired people, as well as with choices leading to social approval, are possibly of special importance.

Second, there must be a cue: the student must notice something. Materials for instruction, whether verbal or pictorial, need to distinguish the relevant cues. Instructional materials are better to the extent that they facilitate the discrimination of cues. Printed materials may do this in a variety of ways - - by varying type, by the use of color, but particularly by means of their organization. Lecturers have a variety of ways of distinguishing cues in auditory language - - by differences in loudness and emphasis, and again by the organization of material. Pictorial presentations obviously have used a variety of ingenious techniques of distinguishing cues - - by simplification, by the addition of pointers and markers, by the use of color and contrast. The general point is that instruction will be enhanced when the stimuli relevant to learning are readily discriminated by the student.

Third, response: the student must do something. Many studies of learning have indicated the importance of student participation. Of course, the doing may be a matter of internally conducted thinking or rehearsal. But whatever form they may take, responses to instructional materials are an essential element in learning. Instructional effectiveness will be increased to the extent that the materials involve the student in doing something with his just-acquired knowledge - transforming it, applying it, using it.

Fourth, reward: the student must get something he wants. Various techniques may be used to bring about satisfaction of this sort. Immediate rewards are presumably more effective than delayed ones. Instruction needs to reinforce the rewards learned in real life. For the student who is motivated to solve problems and to achieve some learning goal, finding out that he has done well is an important reward. Instruction will be improved in effectiveness to the extent that some desired aim can be achieved, and that knowledge of this achievement is given.

Obviously, these four principles described by Miller are considered to have highly general applicability to the design of instruction. They are relevant to the learning of all kinds of students, and presumably to all kinds of learning tasks. These principles may be put to work regardless of whether one is considering the task of a first-grader in learning to print letters, or to the task of a graduate student in understanding a scholarly article on Roman architecture.

The generality of these principles is also the key to their limitations in practical usefulness. To the skilled teacher or designer of instruction, they seem obvious, and such a person would likely aver that he always uses such principles. Most instruction, in fact, could probably be shown to incorporate these four principles in some degree. Even when one or another is not strongly exhibited by instructional materials, it may be expected that an experienced learner (like a college student) will often arrange his own learning conditions to include these principles. He comes with his own motivation, he makes responses to what he reads, sees, or hears, and he arranges his studying objectives so that some achievement will be noticeable. Miller's principles are surely important to instruction, but it is questionable whether they are often violated even in the most traditional instruction.

Skinner. The views of Skinner on instruction are contained in a variety of articles, particularly those on teaching machines (Skinner, 1957, 1958, 1965). Valuable analyses are also contained in books and articles by his students (Gilbert, 1962; Green, 1962). At the most general level, it may be said that no great disagreement can be found with the principles of Miller. Skinner's analysis of instruction assumes that motivation must be present, that the student must make a response, and that this response needs to be rewarded, or "reinforced." The increased specificity of Skinner's suggestions center around the principle of stimulus control, or the ways in which reinforcement may be used to establish both more precise and more elaborate learnings by manipulation of the stimuli impinging on the learner. In this sense, Skinner's views are most highly related to Miller's principle about the importance of the cue in learning. It is possible to interpret Skinnerian principles of instruction as a more extensive account of what must be done to present cues (or stimuli) in such a way as to optimize learning.

Several relatively specific ways of controlling the learning process by suitable sequencing of stimuli and reinforcements are suggested by Skinner's theory. One is the principle of shaping, applicable to the learning of motor acts. As the individual practices a motor response of some sort, reinforcement is given selectively so that the response which is originally only a crude copy of what is acceptable comes by a gradual process to be more and more exact. Such a principle applies, for example, to learning to pronounce an unfamiliar language sound, such as the German umlauted u, or the French uvular r. A second principle, somewhat similar, is that of successive approximation of stimulus control, in which a response which is originally

"prompted" comes to be given properly even when the prompt has been progressively "faded." Initially, a student may need many contextual prompts, for example, to remember what the Constitution says about the powers of the President, but as he continues to practice recounting these powers, he can do it without these extra cues. A third Skinnerian principle is chaining, which describes the conditions of reinforcement by means of which a lengthy procedure is learned. Essentially, the steps in the procedure, which might be a computational procedure in mathematics, for example, are put together in a step-by-step fashion, insuring that the final step is always connected with the others which precede it (cf. Gilbert, 1962).

Thus it may be seen that the learning theory of Skinner leads to some relatively specific suggestions about the design of instruction. It gives us practical procedures for shaping motor responses, for establishing discriminations by successive approximations of stimuli, and for chaining together the steps in complex procedures. For certain kinds of learning tasks, these procedures are indeed specific and undoubtedly successful.

In my view, these principles are still only of general applicability to the learning of certain other kinds of tasks, particularly concepts and principles. For example, if one is concerned that a student acquire an understanding of the principle of separation of powers as defined by the Constitution, or an understanding of the principle of centrifugal force, the notion of successive approximation provides only a very general prescription for instruction. It says one must bring such behavior under finer stimulus control, but it does not specify how to do this. It does not say how to select the stimuli which will accomplish this purpose. It seems to me, therefore, that although some specificity about instruction in certain tasks is definitely gained from Skinnerian theory, for certain others of particular importance in college-level instruction, the suggestions remain highly general.

Gagné. The ideas of this theorist regarding the learning process are contained in a book entitled The Conditions of Learning (1965), and their applicability to instructional practice is discussed in a chapter of another recent book, Instruction: Some Contemporary Viewpoints (Siegel, 1967). The suggestions to be derived from this view of learning are more specific for instruction than are those previously described.

The first principle deserving emphasis is that of distinctive conditions for different kinds of learning. Gagné distinguishes seven major kinds of mental processing which are called learning, each of which has a different

set of conditions for its optimal occurrence. The seven kinds are called signal learning (classical conditioning), S-R learning, motor and verbal chain learning, multiple discrimination, concept learning, principle learning, and problem solving. He considers that the typical learning of young adults, high-school and college students, may partake of any or all of these types of learning, but that some are much more frequent than others in the school environment. For example, certain motor and verbal chains may need to be learned in tackling a new foreign language, but these types of learning would probably never be encountered in courses in history, government, or English composition. Most subjects in high school and college include primarily the kinds of learning described as concept learning, principle learning, and problem solving.

Although all types of learning may require certain general conditions for their establishment, such as those of contiguity, repetition, and reinforcement, emphasized by most learning theorists, the <u>specific</u> conditions for establishment of concepts, principles, and rules are in addition to these. Furthermore, they are distinguishable for each type: learning complex principles through problem solving demands a different set of conditions than does learning a new concept like "cell," "neuron," or "central nervous system." The external conditions for each particular type of learning form the basis for instruction. The internal conditions are retained capabilities of the student which have been established by previous learning.

The second principle of importance for instruction may be called <u>cumulative learning</u>. This is the principle that the learning of any new capability builds upon prior learning. According to this theory, there is a specifiable minimal prerequisite for each new learning task. Unless the learner can recall this prerequisite capability (or some other which can serve the same purpose), he cannot learn the new task. As a very simple example, unless a learner can recall how to factor numbers, how to divide, and how to multiply, he cannot learn to find a lowest common denominator, and thus to add fractions. This principle has a deceptive simplicity about it, and may readily be dismissed as either obvious or trival. In actuality, it is neither. It does not say, before the learner undertakes to learn how to add fractions, he must have "had" or "been through" the factoring of numbers. Instead, it says he must have <u>mastered</u> and must <u>be able to recall</u> the factoring of numbers in order for the desired learning to take place at all. This principle is considered to have broad applicability to the learning of principles, whether it be the origins of the American Revolution, the generation of induced

e" ctric current, or the constancy of perceived size. In all of these instances, there are specific minimal prerequisite learnings, before the new learning task is undertaken.

Ausubel. The views of this learning investigator may be sampled in The Psychology of Meaningful Verbal Learning (1963), and also in an informative chapter in the book Instruction: Some Contemporary Viewpoints (Siegel, 1967).

Ausubel insists, first of all, that school learning is meaningful learning and that this process is distinctly different from what is usually called rote learning. Thus he comes to grips directly and specifically with the learning of facts and principles, and is not particularly concerned with other forms of learning such as motor and verbal chains. In this theory, the most important principle is called subsumption. Meaningful learning takes place, according to this theory, when a new idea is subsumed into a related structure of already existing knowledge. The result of this process is the acquisition of a set of new meanings.

There are a number of implications of this view for instructional practice. For example, one is the importance of providing the learner with a meaningful structure before he attempts to learn a new principle - - an organizer, which bears a logically superordinate relation to what will be learned. Putting this in a somewhat oversimplified form, it means that if the learner is expected to learn about coal and oil and gas, one must tell him ahead of time that he is going to learn about "the different forms of fuel." A second principle is that any subject should be presented by progressive differentiation of content, the most general and inclusive ideas first, and then the more detailed and specific ones. Ausubel states that although this seems a self-evident principle, it is rarely followed in actual teaching procedures or in textbooks.

Still a third principle of importance is called consolidation. This means the insistence on mastery of ongoing lessons before new material is introduced. This proposition is at least highly similar, if not the same, as Gagne's principle of cumulative learning. Another Ausubel principle of great importance would seem to be integrative reconciliation. By this he means that new ideas, once introduced, need to be deliberately related to old ideas, significant similarities and differences pointed out, real or apparent inconsistencies reconciled. Again, Ausubel finds this a practice followed scarcely at all by textbook writers.

These principles add up to a pretty strong specification of how instructional materials should be organized and presented for most effective learning. While one finds only very general guidance for the construction of programs of instruction, texts, or educational films by following such principles as Miller's, it is evident that Ausubel's principles are pretty specific. They tell an instructional designer what to do first, what sequence of ideas to follow, what to do to insure remembering, and what kind of outcome to expect. Note that I do not maintain that Ausubel's theory is entirely correct - - only a good deal more experimentation will determine that. But his ideas lead to very concrete suggestions about how to conduct instruction.

Here then we have four theories of learning, each of which has something to say about how to design instruction. Virtually no instructional materials, texts, or films in existence today have deliberately been prepared on the basis of these principles. Today's instruction simply does not reflect these principles, but appears instead to be based upon an older set of principles derived from quite different considerations. Could instructional materials be designed to take these principles into account? I see no reason why this could not be done. It would be an expensive undertaking, even to design a single course this way. I am unable to estimate cost effectiveness -- indeed this may not even be possible until someone has tried to do it once.

Otherwise, the kinds of principles I have been talking about can even now be put into effect in at least a partial fashion by, first, the instructor, and second, the student. For example, the instructor can use the principle of organizers, and the principle of integrative reconciliation, even though he may not be able in any immediate sense to rewrite the textbook or redesign the television lesson. The student is also able to put many of these principles into effect himself. In fact, it seems probable that what is meant by a sophisticated learner, as opposed to a novice, is one who imposes his own organizations on presentations of material, arranges his own distinctive conditions for learning different kinds of tasks, carries out his own integrative reconciliation of new and old ideas. Learning to do these kinds of intellectual activities, to carry out these kinds of strategies, may represent an educational goal of more fundamental importance than the learning of any particular set of facts, rules, or principles.

Learning and the Individual

This possibility of the learner's contribution to his own learning suggests an even broader theme than any which has been specifically defined by learning theories. Perhaps it may become the most general principle of all. It may be said, surely, that the great majority of modern studies of learning, of a variety of types, provide an accumulating body of evidence for this principle: Learning and remembering require the imposition of an active intellectual process by the learner on the material presented to his senses. One simply cannot account for learning by specifying only what is presented and the level of "intelligence" of the leanner. Apparently, some specific sort of processing is always contributed by the learner himself. This kind of processing is given various names, in various experimental settings. For example:

1. In studies of rote verbal learning, it is typically called mediation (cf. Jenkins, 1963). Learning to associate a nonsense syllable like DEP with a nonsense syllable like RIV has been shown typically to involve the contribution of a linking mediator by the learner. (In this particular instance, it might be a word like "deprive," or two words like "deep river").

2. In still other studies of memory, the process may be referred to as coding (cf. Melton, 1963). Investigations of short-term retention of small verbal units are generally considered to reveal important facts about the "intake" portion of the learning process. Here, it is found that a single syllable like XQR is not retained as well after one presentation as a syllable like NER, nor as well as a word like TOP. In fact, the single syllable XQR is retained no better than three short words. The suggestion is that something is done to these units before they are stored. They are first coded.

3. Investigations of the learning of concepts by children (cf. Kendler, 1964) provide other sources of mediational processes. It is found that children of four years of age cannot shift readily from one concept (like "black") to its opposite, whereas seven-year olds can. By inference, this is because the older children have a greater store of "mediators" to apply to this reversal situation.

4. Many studies of problem solving in young adults (cf. Gagné, 1964), using a variety of tasks, have emphasized the importance of prior knowledge, or an organization based upon prior knowledge (cf. Katona, 1940), to the successful solution of problems. Problems are solved when the learner is able to bring such an organization, which is already available to him, to bear upon the task at hand.

5. Studies by Rothkopf and his associates (cf. Rothkopf, 1966), have shown the important effects on learning and retention resulting from the introduction of questions into textual passages, even when the questions are irrelevant to what is ultimately tested as having been learned. In other words, the inference is that the learner applies to the learning task a complex set of behaviors which may be approximately summarized as a "set to remember."

These are only a few of the many lines of evidence showing that new learning cannot be adequately accounted for in terms of what is presented to the learner. In addition to these external stimuli, a very important part of the process is contributed by the learner himself, or more specifically by what is stored in his central nervous system. Furthermore, it is fairly clear that the coding or mediation done by the learner depends upon his <u>particular</u> store of past experience. The particular way the learner codes a presentation is peculiar to him, and not shared by other individuals. <u>The mediation of learning is idiosyncratic</u>.

The implication of these findings is quite clear. So far as theories of the learning process are concerned, the learning of any set of materials depends importantly upon individual contributions from the learner himself. Learning is an individual matter. In a fundamental sense, it is determined by what the learner does, and not by what the material does or what the teacher does. One can even go a step farther, in drawing implications for education. If one is concerned about how to make learning efficient, the focus of emphasis must be the student. The design of efficient conditions for learning demands that learning be conceived as an individual matter.

Now, there are conflicting views on this question. Some psychologists, looking at the educative process as typically involving a teacher and a class, have emphasized the teacher-student interaction, or what is sometimes called the teaching-learning process. Jackson (1966), for example, distinguishes between teacher-student dialogues which are private (as in a tutoring situation), those which are public (as in a classroom), and those which might be called semi-private, in which the teacher works with a single student while others engage in some other activity. He correctly notes that learning theorists have seldom if ever contributed to an understanding of t public teaching situation. Another theorist about teaching is Thelen 1967), who has carried out a series of most interesting studies of teacher-student interactions, seeking ways of find a "fit" between teachers and groups of students. The absence of change in the school's output resulting from changes in administrative procedures such as class size, team teaching,

ai ..ity grouping, as well as instructional procedures like discussions vs. lectures, leads Stephens (1967), to the conclusion that as long as a teacher has a strong interest in his subject, what he does is relatively unimportant.

For many legitimate purposes, there is surely much to be gained by studying the activities of the teacher, and theorizing about how he interacts or should interact with a learner. But such studies can tell us little about how learning occurs, or how to make it efficient. If we wish to find out about learning, we must begin and end with the human individual who is the learner. We must, in other words, find out what the learner is like, what he needs to know to begin the learning process, and what he needs to do to carry it out. The site of learning is not in a group, nor is it in a relationship between instructor and student. The site of learning is the individual's central nervous system. For this fundamental and unarguable reason, learning is individual. Efficient instruction is designed for the individual learner.

The recognition of the individual character of learning need not blind us to some of the necessities of public communication, with both teachers and other students. Schools and colleges are concerned with the transmission of public knowledge. There is, of course, such a thing as strictly private knowledge, as for example that exhibited in artistic accomplishment. But the schools cannot transmit this private experience, by definition. The communications of knowledge become refined, sharpened, and clarified by public discussion. In schools, therefore, public discussion serves the same highly essential purpose as it serves in other settings in the larger community. In a university setting, there is a great deal of public discussion, and it is highly important for the clarification and refinement of the "messages" that are to be transmitted. Often, discussion takes place in a classroom, among students, and between students and teachers. Much discussion takes place among faculty members. And obviously, a great deal takes place outside of class among students. I believe discussion is a highly important part of school learning. Unfortunately, it must be said that we have no theory as yet of the role of discussion in learning. Such a theory, it may be expected, will not be opposed to a theory of individual learning, but will s plement it.

Instruction and the Individual Learner

It is possible, then, to bring to bear upon the design of instruction some principles of learning theory. These principles range from those which are quite generally applicable to all forms of learning to those which apply

specifically to the learning of concepts and principles of the sort which characterize the bulk of knowledge taught in the schools. In addition, modern studies of learning suggest the clear implication that some idiosyncratic processing of information is done by the learner. This provides a fundamental reason for viewing learning as an individual process, and strongly suggests that individualized instruction represents the route of efficient learning. If arrangements for individual learning are not deliberately made by the system, they presumably will be made by the learner himself. In doing this, he will presumably use whatever media are available, although some may be better adapted for some purposes than are others.

The "arrangements" of the external environment for purposes of efficient learning are what constitute the events of instruction. One should not lose sight of the fact, though, that learning in the sense used here also includes remembering and transfer of learning, since it is these less immediate outcomes that are the true concerns of an educational system. Assuming that these are included, what are the events of instruction that must take place in order for learning to occur?

In framing an answer to this question, I should first point out that according to Gagne's (1967) conception, the conditions of instruction differ with the type of learning being undertaken. Thus one does not design instruction on using a key-punch machine to be the same in its formal characteristics as instruction on how the mechanism of a key-punch machine operates. Or, in learning a foreign language, one does not design instruction on pronouncing words to be the same as instruction on understanding spoken sentences. There are some important distinctions here which should not be overlooked. However, for purposes of the present paper, I shall not elaborate them further. Instead, I shall speak only about the events of instruction applicable to the learning of principles, including facts, generalizations, and rules.

What appear to be the most important events of instruction are the following:

1. Gaining and maintaining attention. Obviously, in order for learning to occur, attention must be attracted in the first place, and then maintained. Many of the stimulation conditions that attract attention have been known for a long time, including such things as change, novelty, appeal to dominant interests. Concerning the maintenance of attention, we know somewhat less. Some clarification has surely been gained by Travers' (1964) demonstration that we only attend to one thing at a time, regardless of how many media channels may be bombarding us. Presumably, maintaining attention is a matter of achieving a set, related to one or more individual goals, which makes the

learner return again and again to the task at hand. Manipulating external stimuli is probably ineffective over the long pull, and one must instead seek ways of reinforcing the motivational state of the learner.

2. Insuring recall of previously acquired knowledge is another important function of instruction. We have seen that recall of prior knowledge is considered an essential condition of learning by both Gagné and Ausubel. When the learner undertakes to learn something new, he must first be reminded of what he already knows which is relevant to that learning.

3. Guiding the learning is done in instruction by verbal or pictorial material that provides "cues" or "hints" to new principles, usually without stating them fully in verbal form. In part, the "organizers" mentioned by Ausubel perform this instructional function. In part, it is done by questions, as Rothkopf's work illustrates. The skilled self-learner, of course, provides his own questions.

4. Providing feedback to the learner on his accomplishments is another function of instruction. One of the surest ways, it seems to me, is by defining the objectives of instruction clearly to the learner, so that he will become aware immediately when he has attained each specific goal. Again, the skilled learner may usually do this himself. Textbooks and other media often seem to neglect badly this essential instructional function.

5. Establishing conditions for remembering and transfer of learning would surely be counted as one of the essential functions of instruction. For purposes of transfer, there needs to be a carefully designed series of problems to which application of the newly learned principle is made. Probably also having this function is the process Ausubel calls "integrative reconciliation," in which new ideas are compared and contrasted to related ones previously learned. For remembering, there needs to be provision for spaced review, which has often been shown to be an effective technique (cf. Davis, 1966, pp. 55-71).

6. Finally, there should be mentioned still another instructional function, often neglected. This is the assessment of outcomes. The outcomes of learning and remembering need to be assessed frequently. The administration of a final test or examination for purposes of determining a grade seems often to be a way of consolidating an onerous task which because of its unmanageable scope ends up avoiding the very assessment that should be done. Learning of the <u>specifics</u> needs to be assessed, perhaps more so than learning of the generalities. The five-minute daily or weekly quiz has much to recommend it. For the skilled learner, this function can often be performed with some success by himself. But to test oneself is indeed a highly

sophisticated thing to do, and instructional materials should provide as much help as possible in this function.

There are, then, these six major functions that take place in instruction. It may be noted that learning theory does not , in and of itself, say exactly how these are to be put together in the great variety of specific instances to which they are applicable. What learning theory tells us is that when certain of these conditions are present, learning will occur, and when certain ones are not present, learning is improbable. Beyond such theory there must of course be both technology and artistry, whether this be exhibited by the textbook writer, the film-maker, or the master teacher. And to a considerable extent, at least, we should expect effective techniques of self-instruction to be present in the young adult.

What Can Media Accomplish?

It can readily be seen that most media of communication can readily perform most of these instructional functions. They can be performed by pictures, by printed language, by auditory language, or by a combination of media. So far as learning is concerned, the medium is not the message. No single medium possesses properties which are uniquely adapted to perform one or a combination of instructional functions. Instead, they all perform some of these functions well, and some not so well. The arrangement of instructional conditions is still the key to effective instruction, regardless of the medium or media employed.

One key to the question of which media is to be found by considering the learning task, that is, the objectives of the learning. A properly defined set of objectives provides information on the nature of stimuli to which the learner is expected to respond, after he has learned. Consider a few examples:

1. An objective in a course in physics might be, "demonstrating Ohm's Law." If one expects the student to show how resistance in a electric circuit varies with the current and voltage, there would seem to be considerable justification for using actual objects and events as the medium for instruction. In other words, one might set up instruction in a laboratory. If the student has sufficient prior acquaintance with such actual objects and events, a pictorial presentation may perform the same functions.

2. An objective in a course in English might be, "editing composed written paragraphs for correctness of structure and optimal clarity of expression." Obviously, what has to be presented here initially are incorrect and non-optimal paragraphs. Printed language has to be the medium.

Hc ver, it may be of considerable importance in such an instance to arrange for frequent and prompt feedback to the learner as he makes his corrections. Thus one might choose to have a teacher convey this feedback in the presence of printed language given in a text or projected on a screen.

3. In a foreign language course, an objective might be, "making appropriate responses containing personal biographical information to questions asked by a speaker in the foreign language." Here again, the medium required is quite evident - - it is auditory language. The learner must be presented with these questions in an auditory form, and the printed form will not be an adequate substitute.

Consideration of these examples, and others like them, leads to the following generalizations concerning the use of media for instruction. These seem to me to be more or less self-evident principles with which one must begin to think about media. They are not "the answers," but merely the basis for further investigation of the uses of media.

1. First, no single medium is likely to have properties that make it best for all purposes. There is, so far as we know, no special magic in any particular medium.

2. Second, the most important single criterion for a choice of medium is often the nature of the learning task itself - - that is, the objective of the instruction. If the learner is going to respond to real objects, these need to be used at some point in instruction. If he is going to respond to auditory language, then this form of communication needs to be used at some point in his instruction. However, it should be noted that this criterion doesn't solve the whole problem, by any means. The reason is that for many objectives, one medium is as appropriate to the task as another. For example, the principle relating the sides and hypotenuse of a right triangle can be presented in printed words, in mathematical symbols, or in diagrammatic pictures. Or, the events leading up to the Boston Massacre can be described in a printed text or shown in dramatized pictorial form. In these instances, nothing in the instructional objective itself provides a clue as to which medium will be best.

3. Third, when one considers the six functions of instruction (controlling attention, stimulating recall, etc.) previously mentioned, it is evident that any given medium may perform one of these functions best at a given time during a period of instrucing, while another medium may perform an instructional function best at another time. That is to say, the precise answer to the question of "which medium" is not to be found by matching courses with media, or even topics with media, but rather in matching specific instructional

functions with media. Within a given topic, for example, attention might best be maintained by the introduction of pictures, whereas guiding learning might best be accomplished by printed verbal instructions, and feedback might be best performed by auditory language. This line of reasoning is developed more fully by Briggs et al (1967), in a monograph on Instructional Media. When one chooses a particular medium for a whole course, or even for the development of an entire topic, one is usually making a judgment that such a medium will be best suited "on the average" for the various instructional functions it must perform.

4. Finally, there is another suggestion to be derived from these considerations about the instructional functions of media. It may be that the most striking effects of instructional planning are to be sought in various combinations of media, where each may perform a particular function best. This does not mean reverting to the idea which Travers' (1964) work calls into question, that simultaneous auditory and visual presentations are superior to either alone. What it means instead is that any given medium might be used alternately with others over relatively short periods of instructional time.

Consider, for example, an instructional situation in which the student reads from a printed text and responds to it by writing problem answers. When the occasion demands, pictures or diagrams are presented to perform the functions of stimulating recall and guiding the learning. Now, as the student works along in this fashion, every so often, when a new subtopic is to be introduced, or special emphasis is to be given, a taped auditory message is introduced, having the primary purpose of controlling attention. Frequent questions are included in the printed text for self-assessment, and feedback is also provided in an auditory form. What would be the effectiveness of this kind of combination of media?

I do not know the answer to this question, and there is no research to provide it. Yet this kind of instructional arrangement, only roughly described in this example, may hold the key to effective instruction, particularly the sort of instruction which depends upon the individual to do a large part of the establishment of learning conditions for himself. Obviously, a good deal of testing of practical alternatives is needed before we can feel confident about the outcome of such plans for instruction.

I have been led in this paper to consider first how learning theory relates to the practical events of instruction. There is little doubt that this relationship can be demonstrated. Depending upon which learning theory

e chooses, the suggestions for practical application to instruction are more or less specific. And running through all theories is the theme that learning is, after all, an individual matter, in which essential idiosyncratic elements must be supplied by the learner himself.

As a practical matter, the events of instruction encompass more processes than are included in learning theories themselves. Instruction involves gaining and controlling attention, stimulating recall, guiding the learning, providing feedback, arranging for remembering, and assessing outcomes. It is these functions that are performed by various media of instruction, and to a considerable degree by the learner himself. One should not expect, I think, to find that a single medium is best fitted to do all of these things. Instead, it seems likely that carefully designed combinations of media may be required to achieve the kind of instruction that is most effective, and which at the same time exploits the properties of media to fullest advantage.

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